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DECLARATION

I, Shuichi Tomita, a professional translator, declare that to the best of my knowledge and belief the following is a true translation into the English language of the document, Japanese Patent Application No. JPAP10-165331, with Applicant's docketing No. 9802432, filed in the Japanese Patent Office on the June 12, 1998, in respect of the U.S. Patent Application Serial No. 09/330,669 filed on June 11, 1999.

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[Title of the Invention]

Ink Jet Recording Apparatus

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[List of the Document attached]

[Name of Document] Specification 1
[Name of Document] Drawing 1
[Name of Document] Abstract 1
[General Power of Attorney No.] 9809263

[Name of the Document] SPECIFICATION

[Title of the Invention] Ink Jet Recording Apparatus

[Scope of Claims for Patent]

[Claim 1] An ink jet recording apparatus which performs a print of an image on a recording sheet by causing an ink jet recording head to discharge ink drops, whereas said ink jet recording apparatus is characterized by ejecting at least a portion of the recording sheet to outside said apparatus after a completion of the print on one side of the recording sheet.

[Claim 2] The ink jet recording apparatus as defined in Claim 1, wherein said at least a portion of the recording sheet ejected to said outside the apparatus includes a surface that has the ink drops discharged.

[Claim 3] The ink jet recording apparatus as defined in Claim 1 or 2, wherein said recording sheet which has been printed on the one side thereof is reversed using a switchback method and is re-transported into said apparatus.

[Claim 4] The ink jet recording apparatus as defined in Claim 1, 2 or 3, wherein a place outside said apparatus to which the recording sheet is ejected is positioned below a position of said print performed with the ink jet recording head.

[Claim 5] The ink jet recording apparatus as defined in any one of Claims 1 - 4, wherein said recoding

sheet is ejected to an upper surface of an input sheet cassette.

[Claim 6] The ink jet recording apparatus as defined in any one of Claims 1 - 5, wherein said recording sheet is transported to a print position by a transport mechanism that includes a transport belt.

[Claim 7] The ink jet recording apparatus as defined in Claim 6, wherein said recording sheet is moved at a speed substantially same as a moving speed of said transport belt when said recording sheet is re-transported to said print position after being reversed.

[Claim 8] The ink jet recording apparatus as defined in any one of Claims 1 - 7, wherein said apparatus includes recording means using said ink jet recording head.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization]

The present invention relates to an ink jet recording apparatus, and more particularly to an ink jet recording apparatus capable of duplex printing (double-sided recording).

[0002]

[Prior Art]

An ink jet recording apparatus has been used widely as an image forming mechanism in printers, copying machines, and so on. Some ink jet recording apparatuses performs a

duplex print for printing images on front and back surfaces of a recording sheet. One example of such is described in Japanese Laid-Open Patent Publication No. JPAP08-337011 (1996). The ink jet recording apparatus of this example includes first and second recording mechanisms which include first and second recording means, respectively, in which the second recording mechanism is arranged above the first recording mechanism. The ink jet recording apparatus further includes first sheet supplying means for supplying a recording sheet to the first recording mechanism, sheet transferring means for transferring the recording sheet, having been fed to the first recording mechanism and undergone a print process, to the second recording mechanism, second sheet supplying means for supplying the recording sheet to the second recording mechanism, and sheet ejecting means for ejecting the recording sheet supplied to the second recording mechanism.

[0003]

During a duplex printing, the ink jet recording apparatus transports a recording sheet from the first sheet supplying means to the first recording mechanism and records on one side of the recording sheet with the first recording mechanism. Then, the recording sheet, thus printed on one side thereof, is guided by a guide member to be transported to the second recording mechanism arranged above the first recording mechanism with the sheet

transferring means. Then, the second recording mechanism is caused to print on the other side of the recording sheet. After that, the recording sheet is ejected outside the apparatus by the sheet ejecting means.

[0004]

[Problems to Be Solved by the Invention]

However, the structure of the ink jet recording apparatus in which, as described above, the recording sheet is transported from the first recording mechanism to the second recording mechanism within the apparatus and the duplex print is performed becomes complex and the apparatus itself becomes relatively large and accordingly expensive due to these two recording mechanisms. In addition, when the recording sheet freshly having a printed image thereon is transported from the first recording mechanism upward to the second recording mechanism, the printed surface of the recording sheet would be rubbed by the guide member. In such an event, the ink jet recording generally requires a predetermined time period to dry ink and, therefore, an image quality is deteriorated if the printed surface is rubbed immediately after the print performance.

[0005]

The present invention is made in view of the above-described background and, therefore, an object of the present invention is to provide an ink jet recording apparatus which generates a stably superior image quality

and has a duplex print capability allowing a downsizing.

[0006]

[Means for Solving the Problem]

To solve the above-described problem, according to Claim 1, an ink jet recording apparatus which performs a print of an image on a recording sheet by causing an ink jet recording head to discharge ink drops, is characterized by ejecting at least a portion of the recording sheet to outside the apparatus after a completion of the print on one side of the recording sheet.

[0007]

According to Claim 2, the ink jet recording apparatus as defined in Claim 1 is characterized in that the portion of the recording sheet ejected to the outside the apparatus includes a surface that has the ink drops discharged.

[0008]

According to Claim 3, the ink jet recording apparatus as defined in Claim 1 or 2 is characterized in that the recording sheet which has been printed on the one side thereof is reversed using a switchback method and is re-transported into the apparatus.

[0009]

According to Claim 4, the ink jet recording apparatus as defined in Claim 1, 2 or 3 is characterized in that a place outside the apparatus to which the recording sheet is ejected is positioned below a position of the print

performed with the ink jet recording head.

[0010]

According to Claim 5, the ink jet recording apparatus as defined in any one of Claims 1 - 4 is characterized in that the recoding sheet is ejected to an upper surface of an input sheet cassette.

[0011]

According to Claim 6, the ink jet recording apparatus as defined in any one of Claims 1 - 5 is characterized in that the recording sheet is transported to a print position by a transport mechanism that includes a transport belt.

[0012]

According to Claim 7, the ink jet recording apparatus as defined in Claim 6 is characterized in that the recording sheet is moved at a speed substantially same as a moving speed of the transport belt when the recording sheet is re-transported to the print position after being reversed.

[0013]

According to Claim 8, the ink jet recording apparatus as defined in any one of Claims 1 - 7 is characterized in that the apparatus includes a recording means using the ink jet recording head.

[0014]

[Embodiments of the Present Invention]

Hereinafter, preferred embodiments of the present

invention will be concretely described with referent to the drawings. FIG. 1 is a perspective view of an exemplary ink jet recording apparatus according to the present invention. FIG. 2 is another perspective view of the ink jet recording apparatus seen from its backside. FIG. 3 is a diagram showing a structure of the ink jet recording apparatus, and FIG. 4 is a diagram for explaining the ink jet recording apparatus.

[0015]

The ink jet recording apparatus includes a recording apparatus body 1 in which a print mechanism 2 including a carriage, a recording head, and an ink cartridge are internally mounted. The carriage is movable in a main scanning direction, the recording head includes an ink jet head and is mounted on the carriage, and the ink cartridge supplies ink to the recording head. The ink jet recording apparatus further includes a sheet cassette 4 (alternatively an input sheet tray) which is detachably arranged at a lower portion of the apparatus and serves as a sheet supplying means capable of loading a plurality of recoding sheets 3 from a front side of the sheet cassette 4. The ink jet recording apparatus further includes a manual input tray 5 arranged for free use in front of the apparatus. The ink jet recording apparatus further includes a sheet ejection tray 6 which is mounted on the rear side of the ink jet printer. The ink jet recording apparatus is

supplied with the recording sheet 3 from the sheet cassette 4 or the manual input tray 5, causes the print mechanism 2 to print a specific image on the recording sheet 3, and then ejects the recording sheet to the sheet ejection tray 6. In addition, an upper cover 7 is openably provided above the sheet ejection tray 6.

[0016]

The print mechanism 2 holds slidably in the main scanning direction (in a direction vertical to the drawing of FIG. 3) the carriage 13 with a main guide rod 11 and a sub-guide rod 12 bridging left and right side plates, not shown. A recording head 14 which includes an ink jet head having nozzles for ejecting yellow (Y), cyan (C), magenta (M), and black (Bk) ink drops, is mounted on the bottom surface of the carriage such that an ink discharge direction is directed downwardly. The carriage is exchangeably provided on the top surface thereof with ink tanks 15 (ink cartridges) for supplying the respective color inks to the recording head 14.

[0017]

Alternatively, the ink jet recording head 14 may be a head unit in which a plurality of recording heads for ejecting respective color ink drops are aligned in the main scanning direction, or a head unit which includes a recording head having a plurality of nozzles for ejecting respective color ink drops. The ink cartridge 15 is secured

to the carriage 13 by a cartridge holding lever 16.

[0018]

To transport the recording sheet 3 in a sub-scanning direction relative to a print position of the recording head 14, a transport belt 23 for transporting the recording sheet 3 with electrostatically attraction is extended between a transport roller 21 and a sub-transport roller 22 and a print support member 24 is provided at a position opposite to the recording head 14 relative to the transfer belt 23. The transport roller 21 preferably has a relatively large diameter (i.e., 30 mm or more) to generate a sufficient amount of electrostatic attraction during the duplex printing and not to cause curvature separation. The transport belt 23 is preferably of medium resistance substance having a volume resistivity in the range of from $10^9 \Omega\text{cm}$ to $10^{12} \Omega\text{cm}$. In addition, a top roller 25 is mounted to press the transport roller 21 via the transport belt 23 so as to determine a transportation angle of the recording sheet 3.

[0019]

To transport the recording sheet 3 from the sheet cassette 4 onto the transfer belt 23, a pick-up roller 26 and a friction pad 27 for separating and feeding the recording sheet 3 one by one are arranged. Also, a guide plate 29 is arranged to transfer the recording sheet 3 to a midway roller 28 arranged to cause the recording sheet 3 to

contact the transfer belt 23. The sheet cassette 4 includes a cassette body 31, a bottom plate 32, and an extension bottom plate 33 which forms a sheet placement plain together with the bottom plate 32. Such a sheet placement plane is extendable by changing the position of the extension bottom plate 33, as shown in Fig. 4, thereby making it possible to use a sheet having a length longer than the cassette body 31. In addition, to the extension bottom plate 33, an end fence 34 for determining the trailing edge of the recording sheet 3 is mounted in a manner steplessly movable lengthwise.

[0020]

Also, to transfer the recording sheet 3 inserted from the manual input tray 5 to the transfer belt 23, there are provided a pick-up roller 35 for picking up the recording sheet 3 placed in the manual input tray 5, feed rollers 36 and 37 for feeding the recording sheet 3, and a guide plate 38 for guiding the recording sheet 3 to the midway roller 28.

[0021]

Further, to eject the recording sheet 3 to the sheet ejection tray 6 after printing, there are provided a guide plate 41 for guiding the recording sheet 3, an ejection roller 42 for ejecting the recording sheet 3 to the sheet ejection tray 6, and an ejection sub-roller 43. The sheet ejection tray 6 can be extended as indicated by phantom

lines in Fig. 4.

[0022]

Further, to transfer the recording sheet 3, tentatively exposed outside the recording apparatus body 1 after the printing, again to the transfer belt 23 so as to conduct the duplex print, there are provided a guide member 45 and a first branch pawl 46. The guide member 45 guides the recording sheet 2, passing through the print position of the recording head 4, in a downwardly slanting direction towards a place between the sheet ejection tray 6 and the sheet cassette 4. The first branch pawl 46 is turnably mounted, in the vicinity of entrance of the guide member 45 and the guide member 41 at the sheet ejection side, to switch the sheet ejection path for the recording sheet 3.

[0023]

Also, in the vicinity of the end edge of the guide member 45, a switchback roller 47 and a switchback sub-roller 48 are provided. The switchback roller 47 is configured to eject the recording sheet 3 towards the upper surface (this is referred to as a standby position for the recording sheet to stay for the re-transportation, that is, a duplex print sheet standby position) of the sheet cassette 4 located outside of the recording apparatus body 1. The switchback roller 47 also re-transfers the recording sheet 3 into the recording apparatus body 1. The switchback roller 47 is positively rotated when transporting the

recording sheet 3 towards an ejection direction after the print on one side of the recording sheet 3. The switchback roller 47, however, is reversely rotated when re-transporting the recording sheet 3 and is stopped at a predetermined time during the ejection of the recording sheet 3 to grip the lengthwise end edge of the recording sheet 3.

[0024]

Further, in an upstream side in the sheet ejection direction by the switchback roller 47 and the switchback sub-roller 48, a second branch pawl 49 is turnably provided to switch the transfer path of the recording sheet 3 between a sheet ejection path to outside of the recording apparatus body 1 and a re-transportation path to re-transport the recording sheet 3 into the recording apparatus body 1. To transfer the recording sheet 3 fed into the recording apparatus body 1 by the reverse rotation of the switchback roller 47 to the transfer belt 23, there are further provided a guide member 51 for guiding the recording sheet 3, a duplex intermediate roller 52 and a duplex intermediate sub-roller 53 for transferring the recording sheet 3, and a transfer roller sub-roller 54 following the transfer roller 21 to transfer the recording sheet 3 to the midway roller 28.

[0025]

Next, an outline of a control unit of the ink jet

recording apparatus is explained with reference to Fig. 4.

The control unit includes a micro processing unit (hereinafter referring to as a CPU) 80 for controlling the entire operations of the ink jet recording apparatus, a ROM 81 for storing various kinds of permanent basic information, a RAM 82 used as a working memory and the like, an image memory 83 for storing data of image information undergone various kinds of processing, a parallel input and output (PIO) port 84, an input buffer 85, a gate array (GA) or a parallel input and output (PIO) port 86, a head drive circuit 88, drivers 89 and 90, and so forth.

[0026]

The PIO port 84 receives image information sent from a host system as well as information indicating whether a print mode is the duplex print mode, a kind of recording sheet, various commands sent from a console panel (not shown), signals sent from various kinds of sensors such as a home position sensor for detecting a home position (a reference position) of the carriage 13, and so forth. In addition, the PIO port 84 sends specific information to the host system and console panel.

[0027]

Also, in accordance with the various kinds of data and signals received via the PIO port 86, the head drive circuit 88 applies driving waveforms to energy generating elements (an electronic-to-mechanical transducer such as a

piezoelectric transducer or an electronic-to-heat transducer such as a heating resistor) of driving nozzles (for discharging ink drops) of the recording head (ink jet head) 6 corresponding to image information, among from a plurality of nozzles each having a plurality of energy generating elements. The drive waveform may be a square wave, a deltaic wave, a sine wave, etc.

[0028]

Further, in accordance with driving data received via the PIO port 86, the driver 89 drives a motor 91 for moving the carriage 13 in the main scanning direction, a motor 92 for rotating the transport roller 21 in the sheet transfer direction (the sub-scanning direction), a motor 93 for rotating the switchback roller 47. Also, the driver 90 drives solenoids 94 and 95 for moving the first and second branch pawls 46 and 49, respectively.

[0029]

Next, an operation of the ink jet recording apparatus is explained with reference to Figs. 6 - 9.

In Fig. 6, when an instruction for the duplex print is given, the first branch pawl 46 is switched to the duplex print side, as shown in Fig. 7, the second branch pawl 49 is switched to the ejection side, and the switchback roller 47 is positively rotated (rotation to forward the recording sheet in the sheet ejection direction). Then, the pick-up roller 26 is driven to rotate

to send the recording sheet 3 from the sheet cassette 4 so that the recording sheet 3 is fed to the transport belt 23 of the transfer roller 21 and is transported by the transfer belt 23 in the sub-scanning direction with the electrostatic attraction. Then, as the carriage 13 is moved in the main scanning direction, the energy generating elements of the recording head 14 are driven in accordance with the recording image, thereby performing a print of a desired image on one side of the recording sheet 3.

[0030]

The recording sheet 3 to which an image print has been completed by the recording head 14 is, since the first branch pawl 46 is switched to the duplex print side, transferred with the guidance by the guide member 45 to a place between the switchback roller 47 and the switchback sub-roller 48. Then, the recording sheet 3 is further transferred by these switchback roller 47 and switchback sub-roller 48 till it is ejected outside the recording apparatus body 1, as shown in Fig. 8. In this operation, upon a time the trailing edge of the recording sheet 3 passes between the switchback roller 47 and the switchback sub-roller 48, the switchback roller 47 is stopped so that, as shown in Fig. 8, the trailing edge of the recording sheet 3 stays at a position between the switchback roller 47 and the switchback sub-roller 48.

[0031]

Then, the operation determines whether a predetermined time period elapses after a completion of the print operation on one side of the recording sheet 3. This predetermined time period determines a time period required for drying the ink drops fell on the surface of the recording sheet 3. Accordingly, when a drying process is not needed, the above-mentioned predetermined time period for the drying the ink drops is not needed, or in this case the predetermined time period can be used for some other purpose. Also, the predetermined time period can be adjusted in accordance with an amount of the ink drops used in the print operation. An amount of ink drops can be measured by calculating the number of black dots (including the color dots) included in the image data.

[0032]

When the predetermined time period has elapsed after the completion of the print on one side of the recording sheet 3, the first branch pawl 46 is switched to the ejection side, as shown in Fig. 9, the second branch pawl 49 is switched to the re-transportation side, and, after that, the switchback roller 47 is reversely driven so as to rotate the intermediate roller 51. Thereby, the recording sheet 3 pinched between the switchback roller 47 and the switchback sub-roller 48 is, as it is being guided by the guide member 51, re-transported to the transfer belt 23 with the intermediate roller 51. In this operation, the

recording sheet 3 is re-transported at a line speed substantially same as that of the transport belt 23. Thus, the recording sheet 3 is transported in close contact with the transport belt 23 so that the printed side of the recording sheet 3 is not rubbed by the transport belt 23.

[0033]

In this way, the recording sheet 3 re-transported is conveyed by the transfer belt 23 to expose its another side to the ink jet recording head 14 for a second print. After the ink jet recording head 14 completes the print operation on the back side of the recording sheet 3, the recording sheet 3 is further transferred via the first branch pawl 46, with the guidance by the guide member 41 arranged at the ejection side. Then, the recording sheet 3 is transferred between the ejection rollers 42 and 43 and is ejected to the sheet ejection tray 6.

[0034]

As such, the ink jet recording apparatus is provided with an open system in which at least a part of the recording sheet 3 is tentatively ejected outside the recording apparatus after a completion of print on one side of the recording sheet. With this open system, a single recording head (recording means) may be sufficient and an inside structure of the recording apparatus may become simple. Moreover, the time for drying the ink drops for the duplex print can be saved which leads to an improvement

of the print quality. In other word, by ejecting the printed side of the recording sheet outside the recording apparatus, the printed side having the ink drops can be dried, thereby improving the print quality.

[0035]

In addition, the operation for the duplex print in which the recording sheet is reversed with the switchback and is re-transported makes the structure for the duplex print simple and, at the same time, allows the predetermined time period for drying the ink drops to be used for other purpose while securely maintaining this predetermined time period. Further, the operation for the duplex print in which the recording sheet is ejected in a downward direction to a position lower than the print position of the ink jet head allows the recording sheet which becomes heavier due to the adhered ink drops to be stably ejected toward the duplex print standby position. In this case, the duplex print standby position can be an upper surface of a sheet feeding means such as the sheet feed tray and the sheet feed cassette, thereby eliminating an extra dedicated duplex print tray. Thus, the structure can be simple.

[0036]

Furthermore, the operation of transporting the recording sheet to the print position with a transferring means using the transfer belt causes no rubbing of the

printed surface of the recording sheet. Also, by re-transporting the recording sheet at a line speed substantially same as that of the transfer belt, the recording sheet can be re-transported without rubbing its printed surface.

[0037]

In the above-described embodiment, the recording sheet is ejected to the place between the sheet ejection tray and the sheet feeding means. As an alternative, for example, in the recording apparatus of the above-described embodiment, it is also possible to make a structure in which the recording sheet after the print on its one side is ejected to the sheet ejection tray and, by using the sheet ejection roller as the switchback roller, the recording sheet can be re-transported from the sheet ejection tray.

[0038]

[Functional Effect of the Invention]

As described above, an ink jet recording apparatus according to Claim 1 is configured to eject at least a portion of a recording sheet to outside the apparatus after a completion of a print on one side of the recording sheet. Thereby, the duplex print can be achieved with a relatively simple structure and an ink drying time can be securely reserved. In addition, rubbing of printed surface is not caused so that print quality is improved.

[0039]

According to Claim 2, the ink jet recording apparatus as defined in Claim 1 is configured to eject a printed surface of the recording sheet which has the ink drops. Therefore, the ink drops discharged can be dried outside the apparatus.

[0040]

According to Claim 3, the ink jet recording apparatus as defined in Claim 1 or 2 is configured to use a switchback to reverse the recording sheet to which a print on one side is completed and is re-transported into the apparatus. Thereby, the recording sheet can be re-transported by a relatively simple structure.

[0041]

According to Claim 4, the ink jet recording apparatus as defined in Claim 1, 2 or 3 is configured to have a structure in which the ejection position of the recording sheet is lower than the position of printing performed with the ink jet head. Thus, the recording sheet having the ink drops can be, in a natural and stable manner, ejected to the duplex print standby position.

[0042]

According to Claim 5, the ink jet recording apparatus as defined in any one of Claims 1 - 4 is configured to eject the recording sheet to an upper surface of a sheet supplying means. Thereby, an extra dedicated tray on which

the recording sheet is put on standby for re-transportation after the print on one side thereof can be eliminated and therefore the structure can become simple.

[0043]

According to Claim 6, the ink jet recording apparatus as defined in any one of Claims 1 - 5 is configured to transport the recording sheet to a print position by a transport mechanism that includes a transport belt. Thus, the recording sheet is protected from being rubbed by its printed side during the duplex print process.

[0012]

According to Claim 7, the ink jet recording apparatus as defined in Claim 6 is configured to move the recording sheet at a speed substantially same as a moving speed of the transport belt when re-transporting the recording sheet in a reversed orientation to the print position. Therefore, the recording sheet is protected from being rubbed by its printed side during the duplex print process.

[0013]

According to Claim 8, the ink jet recording apparatus as defined in any one of Claims 1 - 7 is configured to have a recording means using the ink jet recording head. Thus, it becomes possible to perform a duplex print with a relatively simple structure.

[Brief Description of the Drawings]

Fig. 1 is an illustration of a perspective front view

of an ink jet printer according to an embodiment of the present invention;

Fig. 2 is an illustration of a perspective rear view of the ink jet printer of Fig. 1;

Fig. 3 is an illustration for explaining a mechanical structure of the ink jet printer of Fig. 1;

Fig. 4 is an illustration for explaining a moving component such as a manual input tray, etc.;

Fig. 5 is a block diagram of a control unit of the ink jet printer of Fig. 1;

Fig. 6 is a flowchart for explaining an exemplary procedure of a duplex print operation of the ink jet printer of Fig. 1; and

Figs. 7 - 9 are illustrations for explaining manners of a switchback transportation of a recording sheet in the duplex print operation.

[Description of the Marks]

- 1: apparatus body
- 2: print mechanism
- 3: sheet
- 4: sheet feeding cassette
- 5: manual input tray
- 6: sheet ejection tray
- 13: carriage
- 14: recording head
- 21: transfer roller

23: transfer belt
42: sheet ejection roller
46: first branch pawl
47: switchback roller
49: second branch pawl
53: intermediate drive roller

[Name of Document] Abstract

[abstract]

[Problems to be Solved]

Complex structure and insufficient print quality.

[abstract]

To eject the recording sheet 3 outside the apparatus body 1 after a completion of the print on one side of the recording sheet 3 and to re-transport the recording sheet 3 into the apparatus body for the duplex print.

[Selection of the Drawing] Fig. 3



FIG. 1

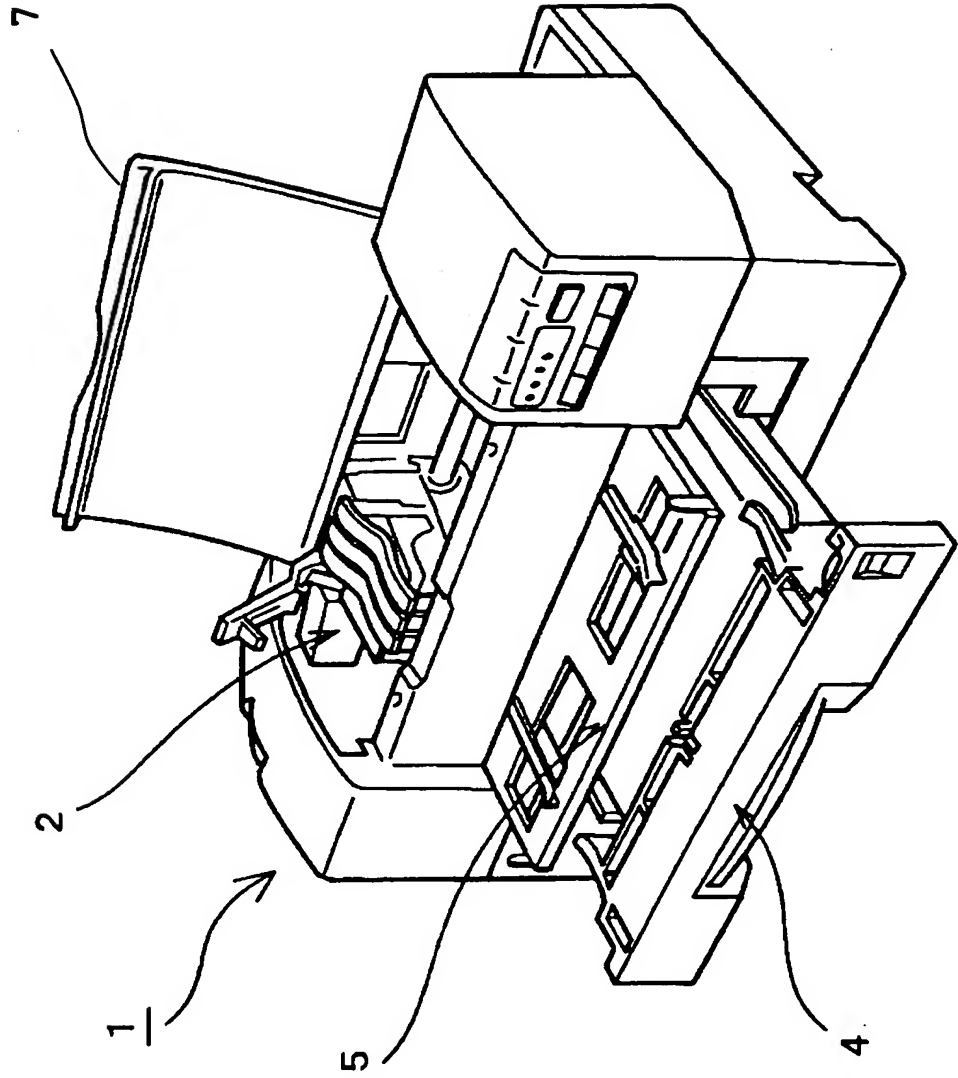


FIG. 2

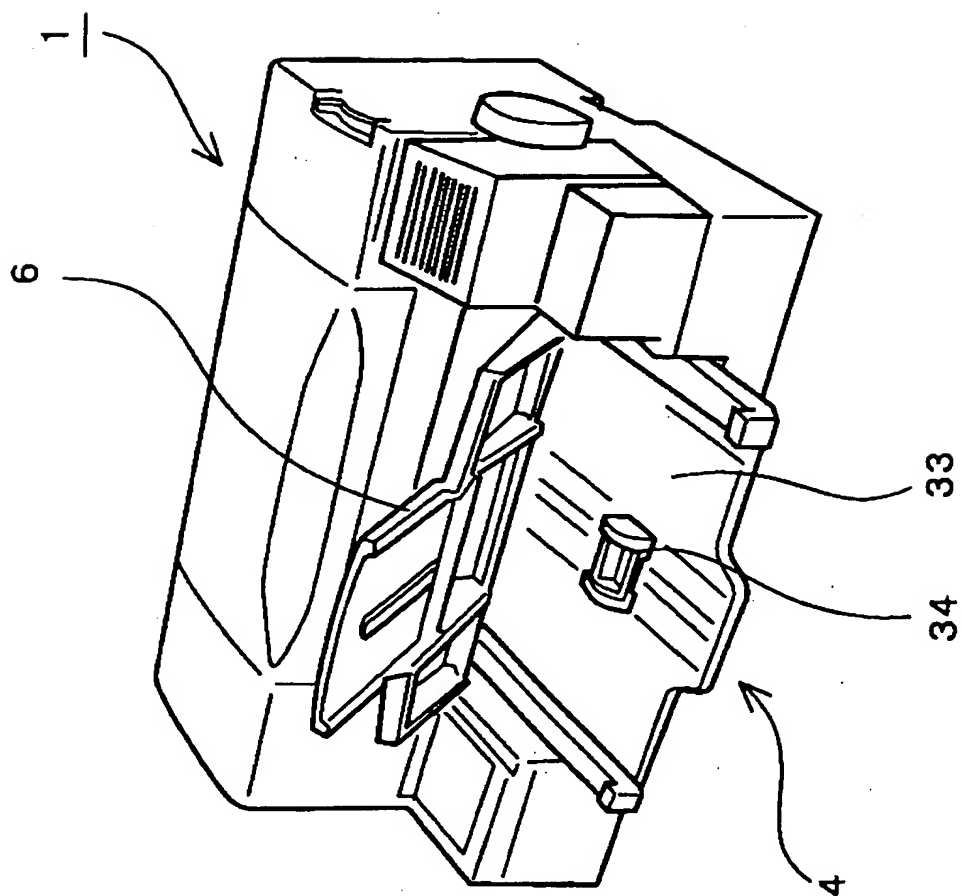


FIG. 3

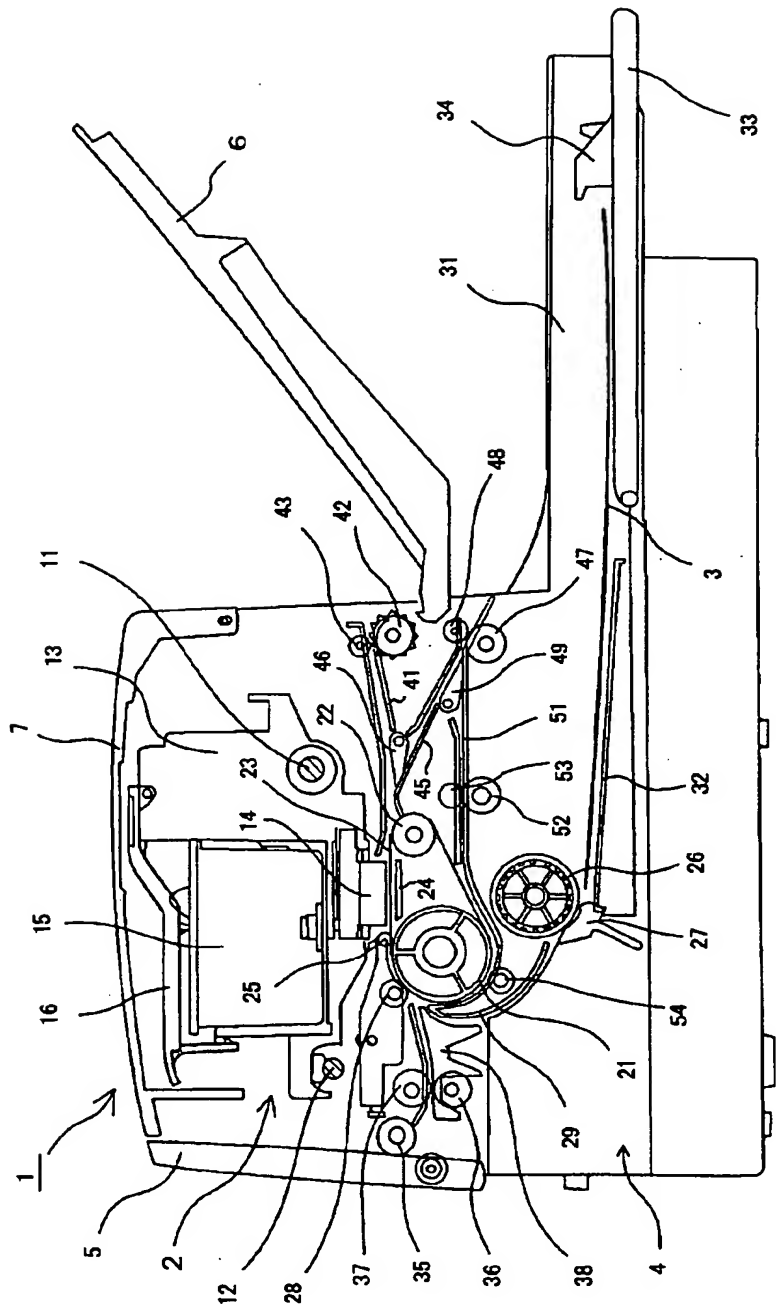


FIG. 4

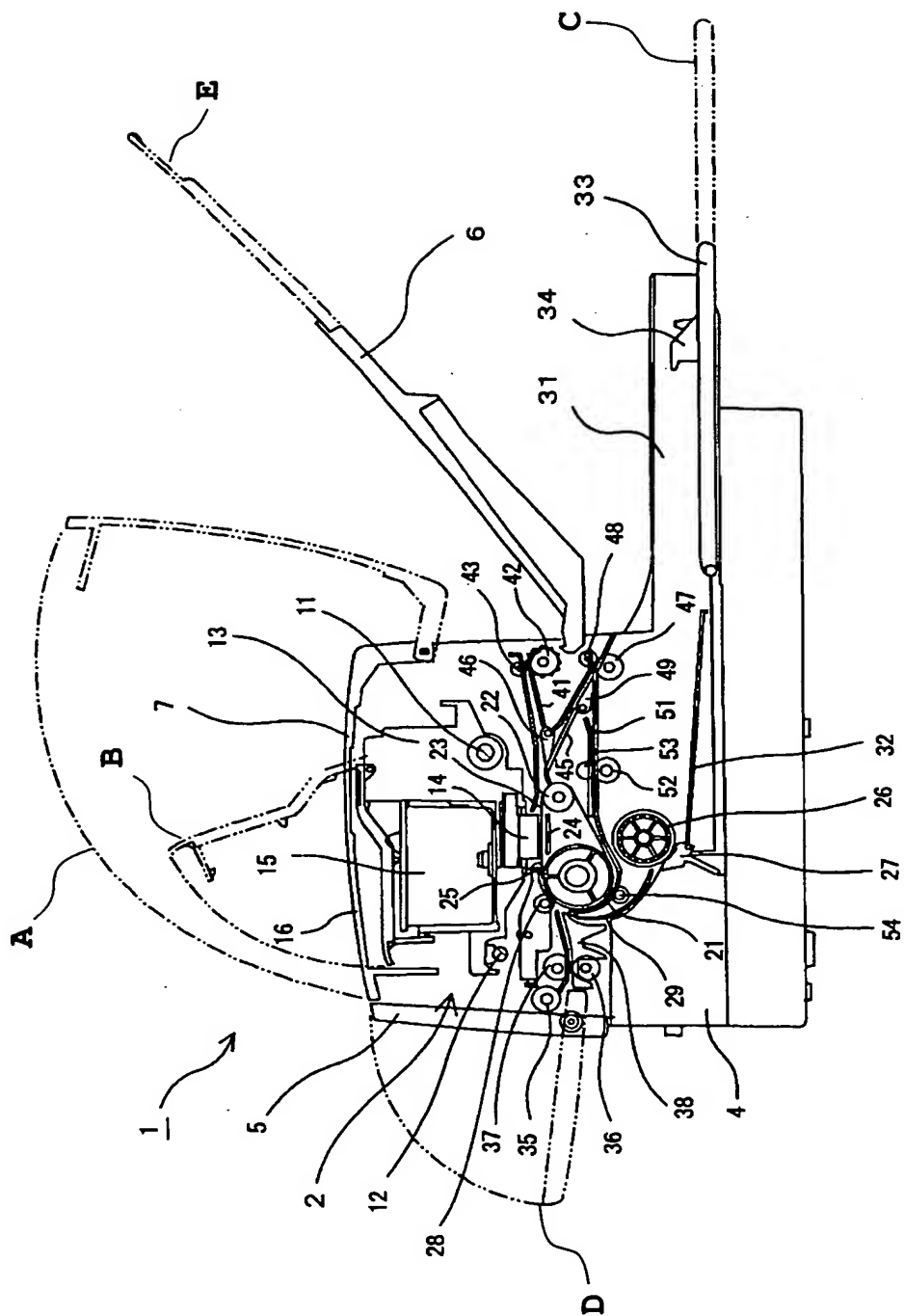


FIG. 5

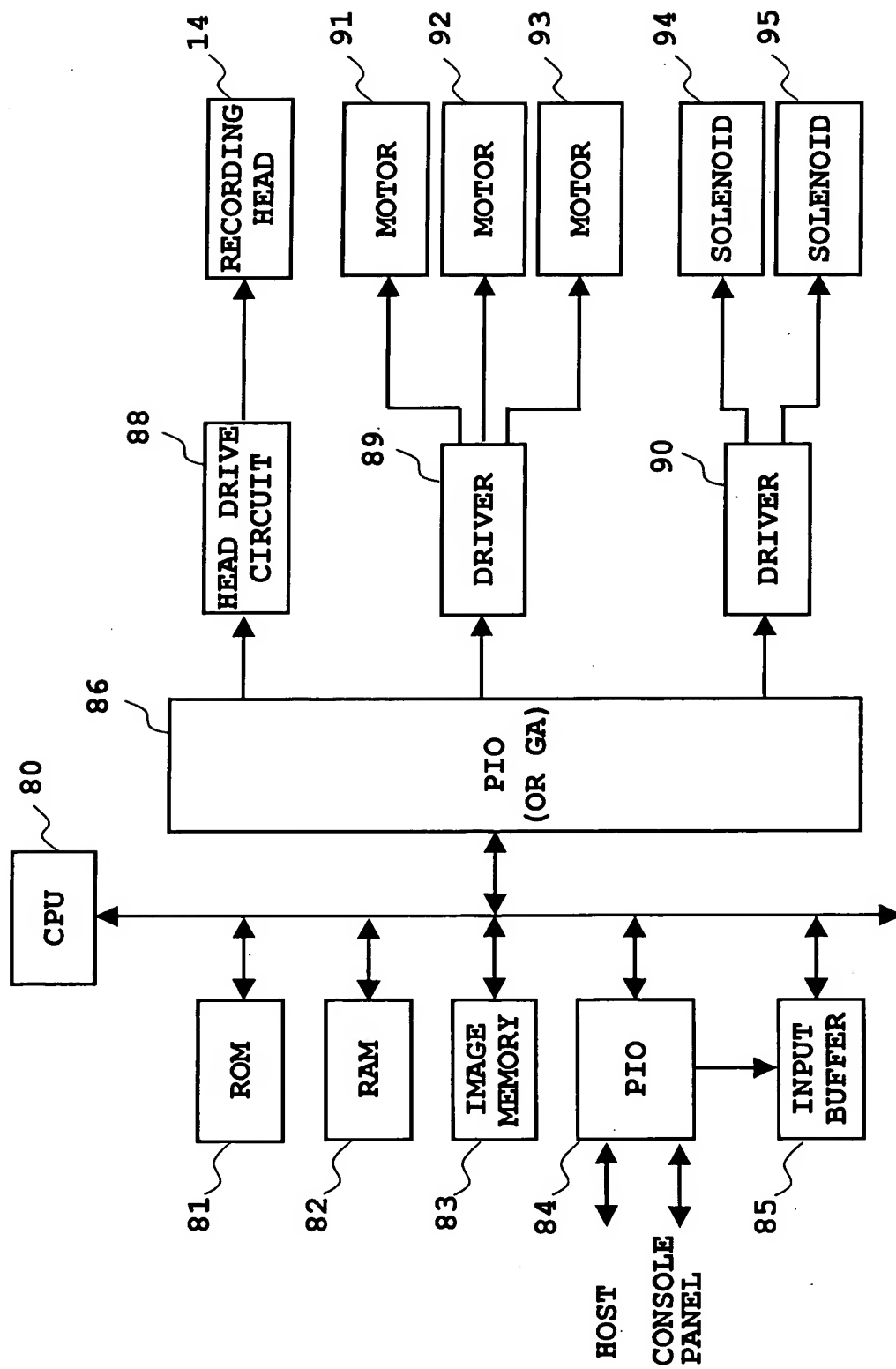


FIG. 6

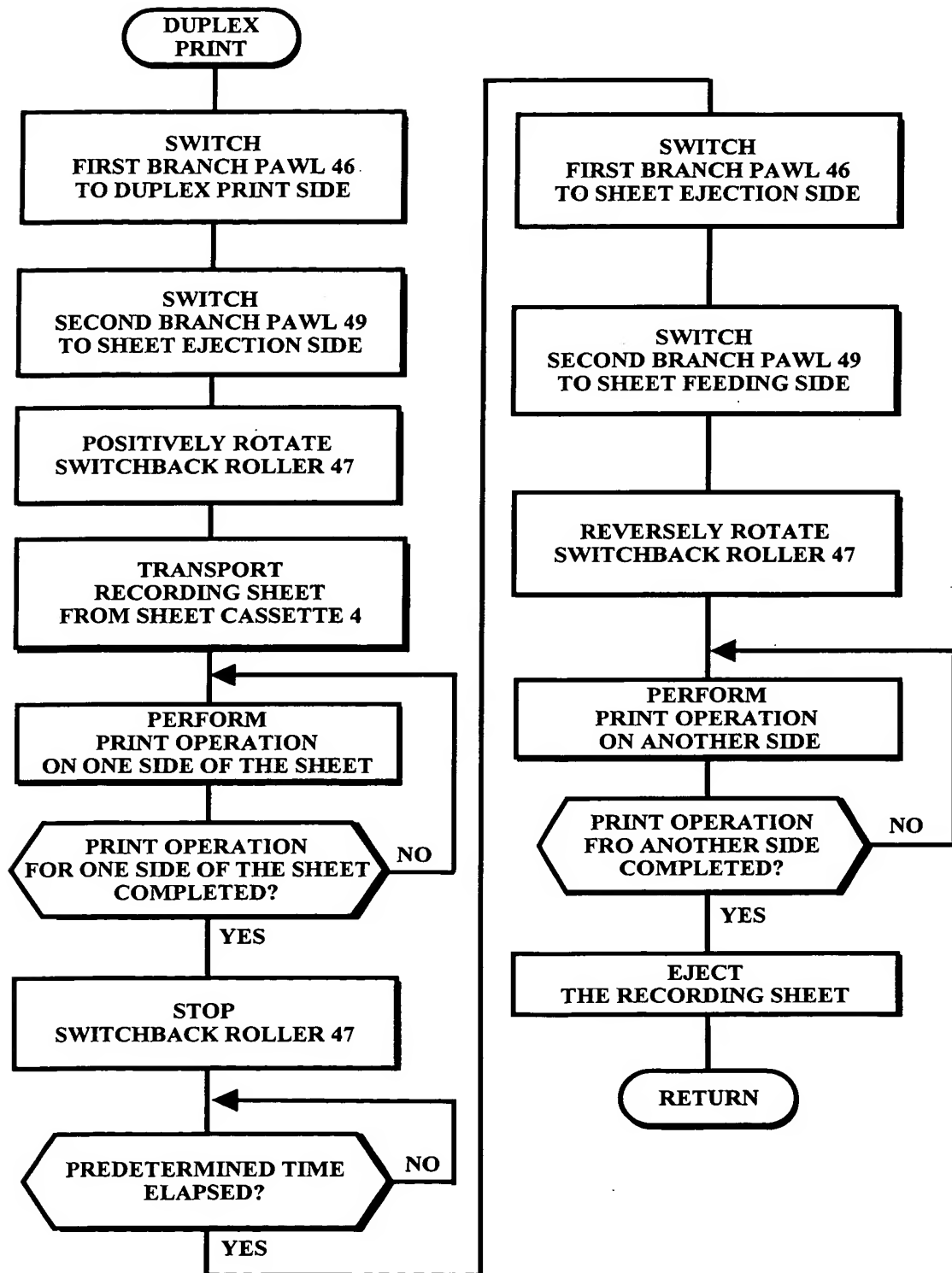


FIG. 7

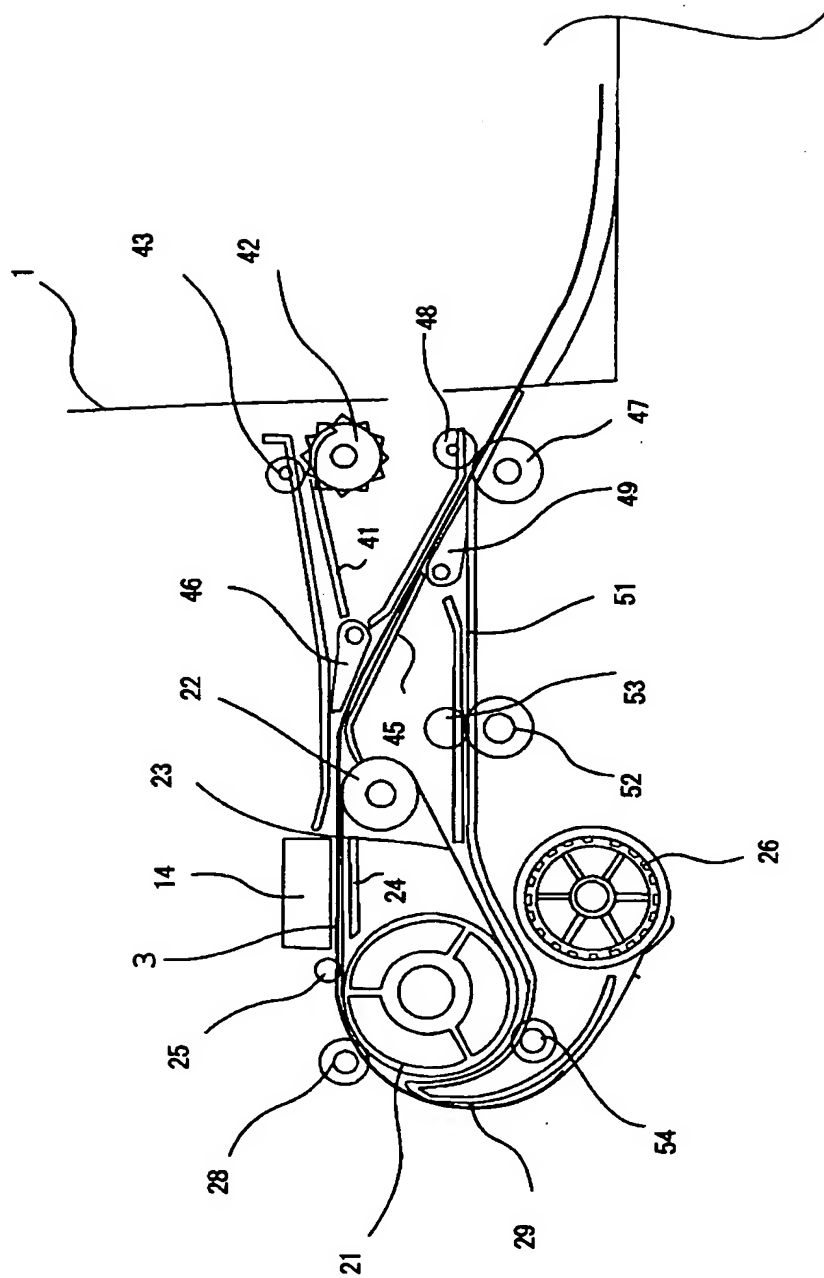


FIG. 8

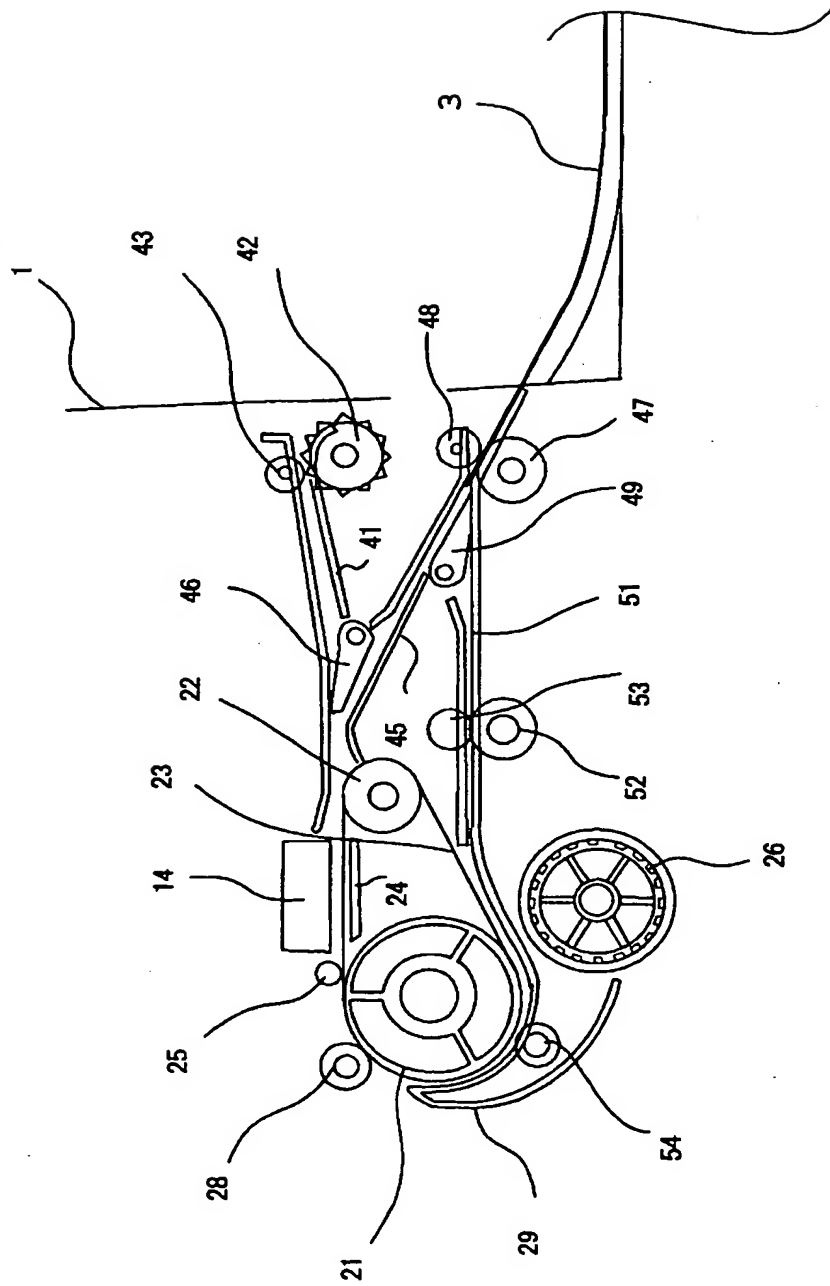


FIG. 9

